

CERAMIC HONEYCOMB FILTER FOR CLEANING EXHAUST GAS

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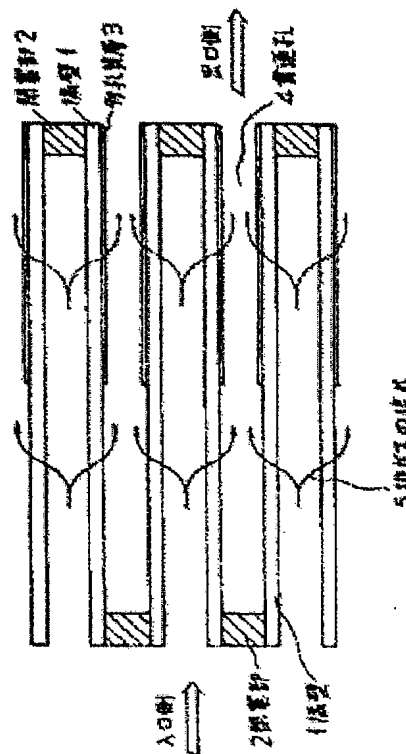
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Abstract of JP63185425

PURPOSE: To facilitate the production of the titled filter and to prevent fusion wear and breakage at a time for regenerating and calcining it by providing a porous ceramic layer having length of (1/10-8/10) of effective total length of the filter on the surface of a partition from the end of an outlet side of exhaust gas.

CONSTITUTION: A ceramic honeycomb filter for cleaning exhaust gas is constituted of partitions 1, the closed parts 2 of through-holes 4, porous ceramic layers 3 and the through-holes 4 compartmented by the partitions 1. It is necessary that the porous ceramic layers 3 are regulated to (1/10-8/10) of effective total length of the filter. Further the effective length of the filter is defined as the effective length of the partitions 1 excepting the closed parts 2. As the ceramic honeycomb structural body, an extrusion-molded form can be preferably used at the point of a uniform shape and the diameter of a pore or the like. The shape of the through-hole 4 is a hexagon and a quadrangle in the cross-section and the filter having $7.7-46.5 \text{ cell/cm}^2$ cell density is preferably used.



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DESCRIPTION

15 1. Title of the Invention

CERAMIC HONEYCOMB FILTER FOR CLEANING EXHAUST GAS

2. Claims

20 1. A ceramic honeycomb filter for cleaning exhaust gas comprising a ceramic honeycomb structural body obtained by extrusion molding, having a large number of through-holes reciprocally closed in the opened end parts with a ceramic material, trapping particulates in exhaust gas by partitions composing said through-holes and accumulating particulates on
25 the partition faces in the exhaust gas inlet side, wherein porous ceramic layers having a length of 1/10 to 8/10 of the effective total length of the filter are formed on the partition faces from the end parts in the exhaust gas outlet side.

30 2. The filter according to claim 1, wherein said ceramic honeycomb structural body is of cordierite.

3. The filter according to claim 2, wherein said porous ceramic layers are of cordierite.

4. The filter according to claim 2, wherein said porous ceramic layers are catalyst-bearing layers.

35 5. The filter according to claim 4, wherein said

catalyst-bearing layers contain γ -alumina as a main component.

6. The filter according to claim 3 or 4, wherein said porous ceramic layers are formed on the partition faces in the exhaust gas outlet side.

5

3. Detailed Description of the Invention (Industrial Field of Application)

The invention relates to a filter for cleaning exhaust gas by trapping particulates containing carbon as a main component in exhaust gas emitted from a combustion engine such as a diesel engine or the like and burning the particulates. (Prior Art)

As a filter for cleaning particulates containing carbon as a main component in exhaust gas emitted from a combustion engine such as a diesel engine or the like, a filter disclosed in, for example, Japanese Patent Application Laid-Open (JP-A) No. 56-124417, which is obtained by reciprocally closing through-holes of a ceramic honeycomb is known.

Since the particulates are accumulated in the partitions to increase pressure loss and lower the engine power, it is required for such a filter to be regenerated by burning the accumulated particulates.

(Problems to Be Solved by the Invention)

In a conventional honeycomb structural body, since the partitions acting as a filter are formed by extrusion molding, the thickness, hole diameter, and porosity are substantially uniform and particulates are accumulated evenly from the exhaust gas inlet side to the outlet side of the partitions or increasingly in the outlet end.

At the time of regeneration by combustion, the particulate layer is successively ignited from the inlet side to the outlet side to carry out regeneration and as described above, in the conventional ceramic honeycomb filter in which the particulates are accumulated in the above-mentioned manner, since the combustion heat generated in the inlet side is

transmitted to the outlet side and further due to the combustion heat of the particulate layer in the outlet side, the temperature of the partitions in the outlet side is sharply increased in the outlet side of the particulate layer and it
5 leads to disadvantageous consequence of melting of the ceramic filter and cracking due the heat impact.

To solve such a disadvantage, JP-A No. 61-129017 discloses to configure a porous ceramic honeycomb structural body by a corrugate method in a manner that the porosity is
10 decreased from the exhaust gas inlet side to the outlet side. However, to produce a filter with such a configuration, ceramic green sheets with different porosities have to be prepared and when a formed body of green sheets with different porosities is fired, since the firing shrinkage ratios of the green sheets
15 differ in accordance with the porosities, it becomes difficult to produce a honeycomb structural body.

Further, since the porosities are specified by ceramic green sheets, in the case of producing filters having various porosities, respective ceramic green sheets have to be
20 prepared.

An object of the present invention is to solve the above-mentioned disadvantages and provide a ceramic honeycomb filter easy to be produced and free from fusion loss and breakage at the time of combustion for regeneration.
25 (Means for Solving the Problems)

The ceramic honeycomb filter for cleaning exhaust gas of the invention comprises a ceramic honeycomb structural body obtained by extrusion molding, having a large number of through-holes reciprocally closed in the opened end parts with
30 a ceramic material, trapping particulates in exhaust gas by partitions composing the through-holes and accumulating particulates on the partition faces in the exhaust gas inlet side and is characterized in that porous ceramic layers having a length of $1/10$ to $8/10$ of the effective total length of the
35 filter are formed on the partition faces from the end parts in

the exhaust gas outlet side.

(Actions)

5 With the above-mentioned configuration, since the portions where the porous ceramic layers are thickened in the thickness of the partitions and the exhaust gas flow passing the partitions is limited, the amount of the particulates accumulated in the portions, that is the soot amount, is decreased to decrease the quantity of heat to be generated at the time of combustion for regeneration and therefore, the outlet side temperature is decreased and at the same time the combustion heat of the soot is absorbed due to the heat capacity of the porous ceramic layers to lower the temperature of the partitions and consequently, melting and breaking of the filter can be avoided.

15 Further, since the filter having various porosities can be obtained by simply covering the partitions of the ceramic honeycomb structural body obtained by extrusion molding with only the porous ceramic layers, the production can be simple.

20 Further, when the porous ceramic layers are formed using an auxiliary material for a catalyst carrier such as γ -alumina or the like and a catalyst such as platinum or the like is deposited, it makes possible to decompose carbon monoxide, hydrocarbons, and nitrogen oxide existing in exhaust gas together with particulates.

25 The portions in which the porous ceramic layers are formed in the invention with a length of $1/10$ to $8/10$ of the effective total length of the filter from the end parts in the exhaust gas outlet side are corresponding to the portions of the partitions in which the heat generation temperature becomes about 700°C or higher in the case no porous ceramic layer is formed and the accumulated particulates are burned and the optimum value may be determined in accordance with the diameter, length, cell density, and the like of the ceramic honeycomb filter; however if the porous ceramic layers have a length 30 within the above-mentioned length, the above-mentioned effect 35

can be caused.

(Examples)

Fig. 1 is a cross-sectional view for explaining one example of a ceramic honeycomb filter for cleaning exhaust gas of the invention. In Fig. 1, the reference numeral 1 denotes partitions of the ceramic honeycomb structural body; 2 denotes closed parts of through-holes 4; 3 denotes porous ceramic layers; 4 denotes through-holes comparted by the partitions 1; and 5 denotes arrows showing the exhaust gas flow. The drawing shows the case the porous ceramic layers 3 are formed on the partitions with a length of $1/2$ of the effective total length of the filter in the exhaust gas outlet side. The effective length of the porous ceramic layers 3 in this invention means the effective filter length of the partitions 1 excluding the closed parts 2.

The ceramic honeycomb structural body is preferably those produced by extrusion molding from a viewpoint of uniform shape, hole diameter, porosity, and productivity and a material for it is preferably cordierite from a viewpoint of heat impact property and porosity. Further, the shape of the through-holes 4 may be a hexagonal, rectangular, round, or another cross-sectional shape, and the number of them is preferable to satisfy the cell density of 7.7 to 46.5 cell/cm² (50 to 300 CPI²). Further, the thickness of the partitions 1 is preferably 0.25 to 0.76 mm (10 to 30 mil).

The closed parts 2 are formed by closing prescribed through-holes of a molded body and fired body of the honeycomb structural body and it is preferable that a material for them is same as that of the ceramic honeycomb structural body.

The porous ceramic layers 3 are formed with the above-mentioned prescribed length from the end part of the exhaust gas outlet side on the partitions 1 in either one or both of the inlet side and outlet side. Further, the porous ceramic layers 3 may also be used as an auxiliary material for catalyst deposition. In this case, the auxiliary material for

catalyst deposition may be formed using γ -alumina or the like and a catalyst such as platinum or the like may be deposited to form catalyst-bearing layers, so that it is made possible to cause redox reaction of carbon monoxide, hydrocarbons, and nitrogen oxide, lower the ignition temperature of soot, and continuously burn accumulated soot.

A material for the porous ceramic layers 3 is selected from ceramic materials in terms of heat resistance and prescribed porosity and in the case the material is same as that of partitions, their thermal expansion coefficients are identical and therefore, it is preferable.

The thickness of the porous ceramic layers 3 is selected in accordance with the thickness and porosity of the partitions 1 and the material and porosity of the porous ceramic layers 3 and it may be made uniform or gradually thicker from the exhaust gas inlet side to the outlet side; however to suppress the temperature increase of the partitions due to the combustion heat of the particulate, it may be made relatively thick. For example, in the case of a cordierite honeycomb with a diameter of 143.8 mm (5.66 inch), length of 152.4 mm (6 inch), porosity of 50%, cell density of 31 cells/cm² (200 CPI²), and thickness of partitions of 0.3 mm (12 mil), it is effective to form the porous ceramic layers 3 in an amount of 400 g on the basis of weight with a length of 8/10 of the effective total length in the exhaust gas outlet side.

Example

Two types of honeycomb structural body made of cordierite as shown in Table 1 were prepared and ceramic honeycomb filters as samples Nos. 1 to 10 within the scope of the invention and reference samples Nos. 11 to 13 having porous ceramic layers of the materials with lengths and weights shown in Table 1 and conventional samples Nos. 14 and 15 having no porous ceramic layer were produced. Each of the obtained filters was disposed in a diesel engine and particulates (soot) containing carbon in an amount shown in Table 1 were deposited on the partitions.

Thereafter, the particulates in the exhaust gas inlet side of the filter are ignited by a burner and the maximum temperature in the side of each filter is measured and at the same time the filter's damage was investigated after the soot combustion.

- 5 The results are shown in Table 1 and the correlation of (length of porous layer from exhaust gas outlet side) / (effective length of filter) and the maximum temperature in the filter is shown in Fig. 2.

Table 1

Sample No.		Filter		Cell structure			Porous layer				Deposited soot amount	Maximum temperature in filter	Filter's damage
		Shape (mm)		Partition thickness (mm)		Density (cell/cm ²)	Material	Size		Weight (g/cm ³)			
		Diameter	Full length	Partition thickness (mm)				Ratio	Length (mm)				
Present invention	1	143.8	152.4	0.3	31	Cordierite	1/10	13	0.14	20	1040	No abnormal	
	2	143.8	152.4	0.3	31	Cordierite	2/10	26	0.14	20	990	No abnormal	
	3	143.8	152.4	0.3	31	Cordierite	4/10	52	0.14	20	860	No abnormal	
	4	143.8	152.4	0.3	31	Cordierite	6/10	79	0.14	20	840	No abnormal	
	5	143.8	152.4	0.3	31	Cordierite	8/10	106	0.14	20	1000	No abnormal	
	6	143.8	355.6	0.4	15	Cordierite	1/10	34	0.14	20	1010	No abnormal	
	7	143.8	355.6	0.4	15	Cordierite	2/10	67	0.14	20	860	No abnormal	
	8	143.8	355.6	0.4	15	Cordierite	6/10	201	0.14	20	680	No abnormal	
	9	143.8	355.6	0.4	15	Cordierite	8/10	268	0.14	20	990	No abnormal	
	10	143.8	152.4	0.3	31	γ-alumina	6/10	79	0.14	20	850	No abnormal	
Reference Example	11	143.8	152.4	0.3	31	Cordierite	0.5/10	7	0.14	20	1160	Broken	
	12	143.8	152.4	0.3	31	Cordierite	9/10	119	0.14	20	1110	Broken	
	13	143.8	152.4	0.3	31	Cordierite	10/10	132	0.14	20	1140	Broken	
Example	14	143.8	152.4	0.3	31	Cordierite	0	0	0	20	1400	Melted	
	15	143.8	355.6	0.4	15	Cordierite	0	0	0	20	1240	Broken	

*The size of porous layers is expressed as the size excluding the Closed parts.

As being made clear from Table 1 and Fig. 2, it is found that maximum temperature in the filters of the samples Nos. 1 to 10 having the porous ceramic layers with a length of 1/10 to 8/10 of the effective total length of the filter from the end parts in the exhaust gas outlet side was lowered as compared with that of the samples 14 and 15 having no porous ceramic layer to cause no breakage and melt loss. Further, in the case of the sample No. 13 having porous ceramic layers in the entire length, it is found that the particulates were evenly deposited in the filter and although the maximum temperature in the filter was lower than that of the sample No. 14, the filter was broken. Further, in the sample No. 10 in which the porous ceramic layers were formed using γ -alumina and used as an auxiliary material for catalyst deposition, the maximum temperature in the filter is lowered to decrease probability of damage.

(Effects of the Invention)

As being made clear from the above description, with respect to a ceramic honeycomb filter for cleaning exhaust gas, the invention makes it easy to obtain a ceramic honeycomb filter with suppressed melt loss and damage at the time of combustion of accumulated particulates for filter regeneration by forming porous ceramic layers with a prescribed effective length from the end part of the exhaust gas outlet side on partitions.

4. Brief Description of Drawings

Fig. 1 is a cross-sectional view for explaining one example of a ceramic honeycomb filter for cleaning exhaust gas of the invention.

Fig. 2 is a graph showing the correlation between the length of the porous ceramic layers and the maximum

1. Partitions
2. Closed parts
3. Porous ceramic layers
4. Through-holes
5. Exhaust gas flow

⑫ 公開特許公報(A)

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⑭ 発明の名称 排ガス浄化用セラミックハニカムフィルタ

⑯ 特 願 昭62-16124

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明 細 書

1. 発明の名称 排ガス浄化用セラミックハニカムフィルタ

2. 特許請求の範囲

1. 押出し成形によって得られた多数の貫通孔を有するセラミックハニカム構造体の開孔端部が交互にセラミック材で閉塞され、該貫通孔を形成する隔壁により排ガス中の微粒子が捕獲され排ガス入口側の隔壁面上に微粒子が蓄積される排ガス浄化用セラミックハニカムフィルタにおいて、排ガス出口側端部からフィルタ有効全長の1/10~8/10の長さを有する多孔質セラミック層を隔壁面上に設けることを特徴とする排ガス浄化用セラミックハニカムフィルタ。
2. 前記セラミックハニカム構造体がコーゼライトである特許請求の範囲第1項記載のフィルタ。
3. 前記多孔質セラミック層がコーゼライトである特許請求の範囲第2項記載のフィルタ。

4. 前記多孔質セラミック層が触媒担持層である特許請求の範囲第2項記載のフィルタ。

5. 前記触媒担持層がγアルミナを主成分とする特許請求の範囲第4項記載のフィルタ。

6. 前記多孔質セラミック層が排ガス出口側の隔壁面上に設けられている特許請求の範囲第3項または第4項記載のフィルタ。

3. 発明の詳細な説明

(産業上の利用分野)

本発明は、ディーゼルエンジン等の燃焼機関から排出される排ガス中の炭素を主成分とする微粒子を捕獲し、その微粒子を燃焼させて排ガスを浄化するフィルタに関するものである。

(従来技術)

ディーゼルエンジン等の燃焼機関から排出される排ガス中の炭素を主成分とする微粒子を浄化するフィルタとしては、セラミックハニカムの貫通孔を交互に閉塞したフィルタが例えば特開昭56-124417号公報において知られている。

このようなフィルタは、微粒子が隔壁に堆積さ

れ圧力損失が大きくなりエンジン性能が低下するため、堆積した微粒子を燃焼させてフィルタを再生させる必要があった。

(発明が解決しようとする問題点)

ところで、従来のハニカム構造体においては、フィルタの作用をする隔壁は押出し成形によって製作されているためその壁厚、気孔径、気孔率は実質的にほぼ一様であり、微粒子は隔壁の排ガス入口側から出口側に向けて一様なしフィルタの出口端では増加して堆積される。

燃焼再生の際には入口側から出口側へ微粒子層が順次着火してフィルタの再生が行なわれるのであるが、上述したように微粒子が堆積した従来のセラミックハニカムフィルタでは、入口側で発生した燃焼熱が出口側へ伝播する一方出口側の微粒子層の燃焼熱のため、出口側隔壁の温度が急上昇してセラミックフィルタが溶融したりまた熱衝撃によりクラックが発生してしまう欠点があった。

この欠点を解消するため、多孔質セラミックハニカム構造体をコルゲート法により排ガス入口側

から出口側に向けて気孔率が減少するよう構成することが特開昭 61-129017 号公報において開示されている。しかしながら、この構造のフィルタを製造するためには、気孔率が異なるセラミックグリーンシートを準備する必要があり、かつ気孔率が異なるグリーンシートの成形体を焼成すると気孔率に応じてグリーンシートの焼成収縮率が異なるため、ハニカム構造体の製造が困難となる欠点があった。

さらに、気孔率はセラミックグリーンシートにより特定されるため、種々の気孔率を有するフィルタを製造する場合、それぞれセラミックグリーンシートを準備する必要があった。

本発明の目的は上述した不具合を解消して、製造が容易で再生燃焼時に溶損や破損の生じないセラミックハニカムフィルタを提供しようとするものである。

(問題点を解決するための手段)

本発明の排ガス浄化用セラミックハニカムフィルタは、押出し成形によって得られた多数の貫通

孔を有するセラミックハニカム構造体の開孔端部が交互にセラミック材で閉塞され、該貫通孔を形成する隔壁により排ガス中の微粒子が捕獲され排ガス入口側の隔壁面上に微粒子が蓄積される排ガス浄化用セラミックハニカムフィルタにおいて、排ガス出口側端部からフィルタ有効全長の $1/10 \sim 8/10$ の長さを有する多孔質セラミック層を隔壁面上に設けることを特徴とするものである。

(作 用)

上述した構成において、多孔質セラミック層を設けた部分は隔壁が厚くなり隔壁を通過する排ガス流が制限されるため、その部分に堆積する微粒子の量すなわちスート量が減少して堆積スートの再生燃焼時に発生する熱量が減少するため出口側の温度が低くなるとともに、多孔質セラミック層の熱容量によりスートの燃焼熱が吸収されて隔壁の温度がより低くなるため、フィルタの溶融、破損を生ずることがない。

また、押出し成形によって得られるセラミックハニカム構造体の隔壁上に単に多孔質セラミック

層を被覆するのみで種々の気孔率を有するフィルタが得られるので、製造は簡単となる。

さらに、多孔質セラミック層をターアルミナ等の触媒担体用補助材で形成して白金等の触媒を担持すると、微粒子の除去とともに排ガス中に存在する一酸化炭素、炭化水素類、窒素酸化物を分解することが可能となる。

なお、本発明で多孔質セラミック層を設けた排ガス出口側端部からフィルタ有効全長の $1/10 \sim 8/10$ の部分は、多孔質セラミック層を設けずに堆積した微粒子が燃焼する際に発熱温度が約 700℃以上となる隔壁の部分に対応しており、セラミックハニカムフィルタの径、長さ、セル密度等により最適な値が定まるものであるが、上述した範囲の長さの多孔質セラミック層であればその効果がある。

(実施例)

第 1 図は本発明の排ガス浄化用セラミックハニカムフィルタの一実施例を説明するための断面図である。第 1 図において、1 はセラミックハニカ

ム構造体の隔壁、2は貫通孔4の閉塞部、3は多孔質セラミック層、4は隔壁1により画成される貫通孔であり、5及び矢印は排ガスの流れを示す。多孔質セラミック層3がフィルタ有効全長の1/2の排ガス出口側の隔壁面上に設けた場合を示している。なお、本発明で多孔質セラミック層3の有効長さは閉塞部2を除く隔壁1の有効フィルタ長さを意味するものとする。

セラミックハニカム構造体としては、均一な形状、気孔径、気孔率、生産性の面から押し出し成形により製造したものが好適に使用でき、その材質は熱衝撃性、気孔率の面からコーゼライトを使用すると好適である。また、貫通孔4の形状としては断面が六角形、四角形、丸形等で、その数はセル密度7.7~46.5セル/cm²(50~300CPI²)のものが好適である。さらに、隔壁1の厚みは0.25~0.76mm(10~30mil)が好適である。

閉塞部2はハニカム構造体の成形体および焼成体の所定の貫通孔を閉塞することにより作製し、その材質はセラミックハニカム構造体の材質と同

一の材質であると好ましい。

多孔質セラミック層3は排ガス出口側の端部から上述した所定の長さにならって排ガスの入口側および出口側の隔壁1上の両方あるいはいずれか一方に設けられる。また、多孔質セラミック層3に触媒担持補助材を兼ねさせることも可能で、その場合この触媒担持補助材をγ-アルミナ等で形成して白金等の触媒を担持させて触媒担持層を形成することにより、微粒子を含む排ガスの浄化とともに排ガス中に含まれる一酸化炭素、炭化水素類、窒素酸化物を酸化還元したり、またスートの着火温度を低くして連続的に体積スートを燃焼させることが可能となる。

多孔質セラミック層3の材質としては、耐熱性および所定の気孔率の面からセラミック材が選ばれ、隔壁と同じ材質の場合熱膨脹係数が一致するため特に好ましい。

多孔質セラミック層3の厚みは、隔壁1の厚さ、気孔率、多孔質セラミック層3の材質および気孔率によって選択され、排ガス入口側から出口側に

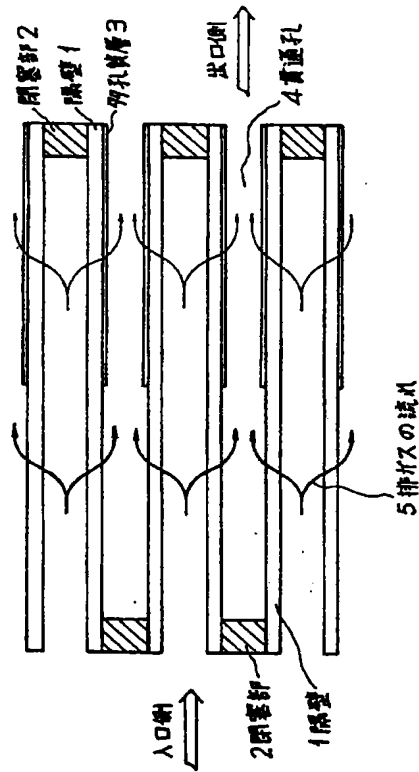
均一な厚さ、あるいは徐々に厚くしてもよいが、微粒子の燃焼熱による隔壁の温度上昇を抑制するためには比較的厚く形成してもよい。例えば、直径143.8mm(5.66インチ)、長さ152.4mm(6インチ)、気孔率50%、セル密度31セル/cm²(200CPI²)、隔壁の厚さ0.3mm(12mil)のコーゼライトハニカムの場合には、重さに換算して全体で400gの多孔質セラミック層3を排ガスの排出側にフィルタ有効全長8/10の有効長さにわたって設けても効果がある。

実施例

第1表に示す二種類の形状のコーゼライトからなるハニカム構造体を準備し、第1表に示す材質、長さ、重量の多孔質セラミック層を設けた本発明品試料№1~10、参考例№11~13および多孔質セラミック層を設けない従来品試料№14、15のセラミックハニカムフィルタを得た。得られたフィルタをディーゼルエンジンに装着して、第1表に示す量の炭素を主成分とする微粒子(スート)を隔壁に堆積させた。その後、フィルタの排ガス

入口側の微粒子にバーナで着火し、各フィルタのフィルタ内最高温度を測定するとともに、スート燃焼後のフィルタ損傷状況を調べた。結果を第1表に、排ガス出口側からの多孔質層の長さ/フィルタ有効全長と、フィルタ内の最高温度との関係を第2図に示す。

第 1 図



第 2 図

